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ABSTRACT

The problems of modeling a process as complex as reading are discussed, including such factors as the lack of agreement surrounding definitions of modeling, varying levels of rigor within and between models, the disjunctive categories within which models fall, and the difficulty of synthesis across fields which employ very different technical language. The author emphasizes the natural tendency for information processing models to cut across traditional disciplines and suggests a conceptual strategy whereby the many models contained in the Davis Report can be approached for synthesis. (Author/AW)

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Modeling the Reading Process: Promise and Problems[1]

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A decade ago, at the 1960 Annual Meeting of the National Reading Conference, Kingston presented a paper which traced briefly the lack of consensus regarding the nature of reading ability, a lack which he felt was responsible for the little advancement in measuring and teaching reading which had occurred over the previous forty years. Kingston concluded that:

> It seems likely that we must seek bold new conceptual frameworks and theoretical designs if we are to make progress. We now give lip service to the idea that reading is a highly complex process. We have discovered that we cannot adequately define it by merely listing its observable attributes. Simularly we cannot explain it by using equally complex and abstract terms [such as "thinking"]. A possible solution to our dilemma may be found... in the use of operational definitions such as those employed in the physical sciences and in current personality research. Such an approach would have the advantage of providing a theoretical framework in which components of reading could be treated separately (10:103).

[1]Paper read at the Twenty-first Annual Meeting National Reading Conference, Tampa, Florida, December 2, 1971

Kingston recommended the development of models as a method helpful in describing and clarifying complex phenomena. He believed that modeling"... has the advantage of enabling one to reason in operational terms and to formulate certain conditions under which various components function or operate in the reading process" (10:103).

In 1971, just eleven years later, we find the situation far different. During the past year, a number of scholars have been reviewing the literature on models of the reading process as part of the USOE's Targeted Research and Development Program in Reading.[2] This work is now complete and detailed reports are available in the final report, entitled The Literature of Research in Reading with Emphasis on Models, edited by the Project Director, Frederick B. Davis (1).

Ninety-seven references were evaluated by the reviewers that were categorized as presenting comprehensive or partial models of the reading process or of processes related to reading. Included within these references were at least seventy-seven distinct works classified as models. Eight of these were classified as comprehensive models of the reading process. The remainder were comprehensive and partial models of processes involved in or related to reading. Only three of the ninety-seven references were published prior to 1960. Of the reading process models only Holmes' Substrata Factor Theory (8,9) predates 1960, the next earliest being my own model first presented in 1966 (2,3).

[2] Scholars involved in the review of models of the reading process were Frederick B. Davis, Robert Efron, Albert Kingston, Paul Kolers, Jane Mackworth, Norman Mackworth, Karl Pribram, Richard Schiffman, Stanley Wanat, and Wendall Weaver, The writer was coordinator of this area and Associate Director of the Literature Search Project.

In 1971, then, we are faced with an embarrassment of riches. Not all of the models are equally useful, of course, and many represent processes whose relationships to reading are quite remote. In a section of the Davis Report, I reviewed forty-eight models which seemed to me to be the most useful (4). Even this reduced corpus, however, includes a bewildering array of complex models requiring a sophistocated understanding of a number of disciplines to assay. This corpus comprises a large body of theory, empirically based and recent, rich in both promise and problems.

Some of the major problems associated with this large body of models are the focus of a paper contributed to the Davis Report by Kingston (11). The issues and questions raised by Kingston must be met if the promise of this new body of knowledge is to prove useful. In the remainder of this paper, I will discuss these problems and suggest the conceptual strategy which seems to me most promising in meeting them.

Model Types and Definitions

As Kingston states, the word "model" is one of today's most popular words (11:VIII 61). It would be difficult to formulate a definition abstract enough to include all things called models. This is a problem of some concern to philosophers of science and considerable efforts on this problem have been devoted to the sorts of things philosophers do. Yet this seems to be the type of problem best left to the philosophers and I would not wish to see a moratorium on modeling until the philosophers reached agreement.

I personally like the distinction drawn by Kingston in the 1960 paper. A model is a form of reasoning. It represents a preliminary stage of thinking and it is expected to require alteration and expansion. It does not explain all of the many questions concerning a phenomenon, but it has the virtue of combining many known facts into a broad conceptual framework (10:103). Seen in this way, a model is a working approximation of the more formal theory.

To the serious student of a process as complex as reading, some device which allows a tentative conceptualization of the whole is an ever-present necessity if he is to avoid recapitulating the history of experimental psychology by becoming absorbed into the fine points of light-time relationships, visual masking effects, retinal hemifield parameters, fixed retinal images, Maxwellian views, and the like. He must keep in mind constantly that his field is understanding reading, and that such fine points are means to that end, not ends in themselves. A model is a very useful tool for this purpose, and the relationship this form of modeling might bear to mathematical formula, computer programs, and other reasoning methods also called models is not an overriding question. Neither is it a question which will go away, however, for it creates subsidary problems which will be discussed below.

Level of Rigor

One of the most serious problems facing the scholar who uses modeling as a method of reasoning is the question of the level of confidence at which one publishes. The nature of the modeling process ensures that all elements of a model will not be equally verifiable. One may have considerable evidence and confidence in some components, e.g., short-term memory components, but little more than a feeling of logical necessity about others. One can publish a tight paper on short-term memory in an appropriate journal and this should be done. But such papers will contribute little to our understanding of reading until someone relates them to the larger process, and this is the function of the model.

Consequently, there is a wide difference in level of rigor employed between components of the same model and between models. These differences are not too serious in the basic contributing disciplines where the level of technical sophistocation of the readership and traditions of vigorous controversy are controlling factors.

In an applied field such as reading, with a tradition of presenting all ideas as final scientific truth, the problem is serious indeed. It is remarkably easy to tack together a composite of borrowed components and rank speculations buttressed by this or that reference into a new "model". Such models have already been produced and more can be expected momentarily. All the possible answers to this problem which I can think of tend to be hopelessly pious exhortations. Perhaps a modeling fad will at least expose to view the level of theorizing which has been true of reading for some years. When it passes, quickly as do all educational fads, it may leave in its wake a residue of scholars seriously interested in the ideas. In the meantime, let the buyer beware. All PERT charts, wiring diagrams, and computer programs should be judged with extreme caution and all components not accompanied by a full discussion of the evidence should be viewed as soneone's guess. Be particularly wary of models which "predict" only that evidence from which they were constructed. And be suspicious of any model which springs forth full-blown, as if from the forehead of Zeus. Miraculous conception is as rare in this field as in any other.

Disjunctive Categories

The major criticism in the Davis Report paper contributed by Kingston was that the models represent disjunctive categories. He states:

> One can, quite correctly, ask the question: What relationship does the model have to the reading process as commonly seen? The variation among so-called partial reading models attests to the diversity in background and interests of those concerned with reading. Language acquisition and utilization models, psycholinguistic models, information-theory models, perceptual models, learning models represent disjunctive categories. There is an urgent need to bridge these categories or to unite them in a logical manner. Right now it is doubtful if an Aristotle would understand the cumulative effect of these models. Certainly, they fail to help us understand the complexities of the reading process (11:VIII 62).

While I can easily empathize with the distress this paragraph represents, I find myself in disagreement with the details. I think the body of models has done much to help us understand the complexities of the reading process, if only to remove them from the lip service level deplored by Kingston in 1960. Those complexities are now explicit -- they can be reviewed, considered, tested. It can be confidently predicted that the models will have to become much <u>more</u> complex before they bear much relationship to the reading process as commonly seen. But then, we have long known that reading is a complex process and that merely substituting equally abstract terms such as "thinking" does not explain it.

I would also disagree that model categories are disjunctive, at least in the sense that word is employed in logic, *viz.*, two or more alternatives, only one of which can be true. It seems feasible that models of the reading process could be developed from a number of viewpoints which would not only be valid but which would supplement each other in our understanding of the whole. But perhaps Kingston meant the term "disjunctive" in its entomological sense, *viz.*, having the head, thorax, and abdomen separated by deep constrictions. This sense of the term comes close to the situation: that the very evident separations between model categories are more structural than functional. In reality all are interconnected in a general system.

The basic problem Kingston calls attention to is, nonetheless, real: seventy-seven models are not a whole lot better than none, if one is looking for immediate application to the classroom. There is a need for the synthesis he calls for, a need which was anticipated from the start. Much synthesis is already reflected in many of the models and this process can be expected to continue as the data base grows.

The task of synthesis, while technical and difficult, will not be as formidable as it appears at first sight. Indeed, I would class the potential for synthesis as one of the major promises of this body of models, rather than one of the problems. A more serious problem for the field will be the need to wait for such synthesis to occur, rather than running off in seventy-seven directions with new reading programs based on some model. I have already been scheduled to take part in a conference program discussing the implications of these models to education.

Many models which are quite similar in their essential components appear more dissimilar than they actually are for two reasons. The first is the frequently accompanying diagram which is drawn to highlight and magnify differences with competing models, and which in different models can make identical components appear unrelated. These diagrams are becoming more standardized, however, as modelers borrow effective techniques from each other. The second, and more fundamental, reason is the use of highly idiosyncratic, even exotic, names for the same basic components. Thus, short term memory components can masquerade under such varied nomenclature as visual image, iconic store, echo box, perceptual image, STM, VSTM, R Buffer, VIS, AIS, IMS, iconic buffer, waiting room, sensory register, logogen, STVM, short-term store, primary memory, short-term reproductive memory, hologram, and many others. While that list includes more than one system, it does represent a very few. This imaginative nomenclature may turn out to be an advantage in the long run, as it prevents "synthesis" on the basis of clang associations. One must know the research upon which the models are based to understand how many genuine differences these words represent.

Another factor which will ease the task of synthesis is that modelers choose domains of varying size for models of correspondingly varying detail. These differences in levels of models occur within the same category. Thus a model of general information flow with a relatively empty box representing short-term memory might be matched with detailed models of that specific component. This matching must be done on the basis of the research from which the models were generated -- one important function of reporting one's reasoning in model form is to guide the reader to this research.

A Conceptual Strategy for Synthesis

One danger in attempting to synthesize a number of models is that each such attempt may only add a new model to the pile. This danger will be least if synthesis proceeds slowly and naturally as a function of normal scholarly activity. This activity should include full credit for borrowed ideas and would be strengthened if the use a borrowed model was put to had the concurrence of the original modeler. At the very least synthesis should be accompanied by considerable communication between scholars. Since this communication will be between specialists in a variety of disciplines, not the least difficult task will be the development of approaches and terminologies that will allow these scholars to interact meaningfully.

In reviewing the body of models for my contribution to the Davis Report, I was impressed with the potential of information-processing models to cut across the boundaries of traditionally discrete disciplines. All such models, and they comprise the bulk of the models related to the reading process, are concerned with the flow of information through the organism. This central concern creates a parallelism between models, whether written from a psycholinguistic or a neurological point-of-view. This parallelism, in turn, creates such a strong tendency toward synthesis that such models frequently mix evidence from a variety of disciplines in their discussions of components.

In reviewing the information-processing models, I gradually became aware that the basic discipline from which the model was written was a relatively unimportant distinction, but that there was another dimension which could serve fruitfully as a basis for analysis and synthesis. This was the degree to which the model dealt with one or more of three concerns. These concerns are Type S, the programs by which the stimulus is analyzed to yield useful information; Type O, the organismic systems and operations involved in processing information; and Type N, the neural substrates underlying components of behavior. These three types of concerns, while logically and experimentally separable, are so complementary that the distinctions between them have been blurred in most models.

In a paper delivered to the American Psychological Association this fall (5), I briefly described the S, O, and N categories. From reactions I have received, it is apparent that two sources of misunderstanding occurred which can be clarified by discussing these categories more fully. First, the categories are not intended, and will not serve usefully, as a taxonomy for the classification of models, since most models mix these categories. Such mixtures are not always successful, the modeler inevitably being stronger in one category than another.

A second difficulty arose due to the similarity of the categories S, O, N with the SOR distinctions of classic psychology. For that reason I shall add a "prime" to the S and O of the categories suggested here. The distinction is fundamental. If we were to represent a SOR situation as a rectangle with the long axis representing time, we could divide the rectangle into its SOR components with two vertical lines. The same rectangle would be divided into its S'O'N components by two <u>horizontal</u> lines. In other words, S' models are concerned with all that happens to the information presented in the stimulus throughout the SOR situation. O'models seek to delineate the organismic systems and their operating characteristics which are utilized during the flow of information.

Models representing pure forms are rare, but three such exist for the initial input stages of visual perception. Gibson's work on the analysis of critical features in letter recognition is concerned with the stimulus characteristics extracted by the organism to effect recognition (6,7). As such, it falls within the Type S' category. Noton and Starks' scan path hypothesis is concerned with the operation of the attention components in vision and is a Type O' model (12,13). The neurological model of the orienting reflex by Sokolov (14) is a Type N model. These three models are in no sense disjunctive or competing, but to the extend they are valid, complement each other in presenting an understanding of the total input process.

As a strategy for synthesis, the development and synthesis of information-processing models in the three categories suggested holds much promise for the understanding of reading. Central to this task is the development of the O' model. The ramifications of a comprehensive and valid Type O' model to reading measurement, diagnosis and remediation are rich and almost unexplored. Combined with the Type S' and N models, a truly diagnostic-prescriptive approach to individualized reading instruction could become more than an idealistic slogan. It cannot happen tomorrow, but it will not happen at all unless we get on with the task.

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